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(S) ANALYSIS OF THE PHYSICAL ENVIRONMENT AT
ALEYSK ICBM COMPLEX

MAY 1965

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(S) ANALYSIS OF THE PHYSICAL ENVIRONMENT AT
ALEYSK ICBM COMPLEX

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PREPARED BY
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PREFACE

This all-source study, which supplements earlier reports SAO/PC 270/1-1-64 and SAO/PC 270/1-2-64, presents an analysis of the engineering geology at the Aleysk ICBM Complex. The purpose of this analysis is to provide data that can be used to evaluate the extent to which terrain and geologic conditions probably have affected construction of the complex and will influence its physical vulnerability. Knowledge gained regarding Soviet physical environment requirements for ICBM sites may aid in locating additional sites in a complex as well as in locating new complexes.

LOCATION OF SOVIET ICBM COMPLEX



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ANALYSIS OF THE PHYSICAL ENVIRONMENT AT THE ALEYSK ICBM COMPLEX

Section I. INTRODUCTION

The physical environment in the vicinity of the Aleysk ICBM complex has been analyzed and the engineering-geology conditions at each launch site are presented.

The Aleysk ICBM complex at the time of study consisted of six Type III (single) sites in various stages of construction. The complex is located on the gently undulating southeastern edge of the West Siberian Plain; it is 150 nautical miles south of Novosibirsk, 160 nautical miles northeast of Semipalatinsk, and is adjacent to the Turkestan-Siberian Railroad. Most of the area is farmland consisting of large-scale, mechanized collective farms which produce field and garden crops, and also state farms, which specialize in wheat, sugar beets, cattle, and poultry. The Aleysk area has a semiarid continental climate characterized by long, cold winters, and mild, occasionally hot, summers. All climate data in this study except frost depths are based on statistics for Barnaul, approximately 48 nautical miles northeast of Aleysk and site of the nearest weather reporting station; frost depth information is based on data from other locations with similar temperature regimes. Seasonal frost is estimated to penetrate to a maximum depth of about 8 feet; permanently frozen ground (permafrost) does not occur in or near the study area. Snow cover persists throughout the winter; it commonly accumulates to a depth of 11 inches by mid-February but extreme depths of 20 inches have been recorded. Duststorms occasionally reduce visibility to a few hundred feet, and small trees may be buried under as much as 15 feet of dust. Occasional mild earthquakes occur in the Aleysk area, but none have reached a damaging intensity (6 on the Mercalli-Cancani scale).

Section II. ENGINEERING GEOLOGY

Analysis of the physical environment at the ICBM complex is based on a study of Soviet literature, primarily in the fields of geology and soils, modified by interpretation of TALENT-KEYHOLE photography. Environmental data to support this analysis are presented in the accompanying table and graphics.

Components of the Aleysk complex are situated northwest of the Aley River on a well-drained, gently undulating plain. Alluvial silt and clay (Units 1 and 2) occur on the flood plain of the Aley River and on the valley floors (flood plains) of intermittent tributary streams. The soils on ancient terraces adjacent to the flood plain of the Aley River consist dominantly of silty sand, 70 to 90 feet thick, with a clayey silt (loess) cover (Unit 3). The surface materials at the Launch sites consist of loess, 1 to 35 feet thick, overlying alternate layers of silt and silty clay (Unit 4), about 300 feet thick. The surficial loess cover generally is lacking on areas adjoining intermittent drainageways, and a stratum of silt and silty clay (Unit 5) occurs at the surface in these areas. Lacustrine clay deposits (Units 6 and 7) several hundred feet thick underlie all the other deposits in the area and do not occur at the ground surface. Bedrock is not known to occur within 300 feet of the surface anywhere within the mapped area.

Large quantities of surface water are available from the Aley River between early spring and early fall, but none is readily available most of the winter, when the river is frozen; characteristically, this water is of poor quality, in part because of its turbidity and in part because of its high content of dissolved solids. Meager to small quantities of ground water are available from terraces bordering the Aley River, elsewhere only locally from discontinuous, perched water tables, at great depth.

Good natural construction materials do not occur in the mapped area. The silts and clays which predominate are poor for most construction uses, and the silty sand on the ancient terraces is only slightly better for construction use than the silts and clays. Coarse-grained soils other than the silty sand do not occur in quantities feasible to exploit. Rock suitable for crushing also does not occur in the mapped area. Except for a few very small stands of birch and aspen, mostly suitable only for fuel, there is no timber exploitable for construction purposes.

Natural foundation conditions for surface structures are generally poor to very poor. Both the silts and clays have low bearing strength when wet, and the silts are subject to liquefaction when saturated, a condition most likely to occur during the period of spring thaw. The silts and clays are also subject to moderate to severe frost action. Foundation conditions for deep silo structures are fair to very poor; the low bearing strengths of the soils would be compensated for to some degree by the probable absence of saturated conditions at great depths. Shallow excavations would be easy to dig, but walls would require moderate to heavy support except in the loess layer, where walls of excavations would be quite stable. Seismic velocities of all surface and near-surface materials generally are low.

LAUNCH SITE 1

Launch Site 1 is located about 6.8 nautical miles west-southwest of Aleysk. It is on a nearly level, cultivated plain near the head of a shallow tributary drainageway to the Aley River. Total relief within 1 nautical mile of the site is less than 50 feet.

The site is on very deep unconsolidated materials consisting of about 25 feet of loess overlying 150 feet of alternate sandy silt and silty clay beds containing a few layers of loess and some lenses of silty sand. The water table is very deep. Ground water occurs in perched water tables, mainly in the silty sand lenses, and quantities are meager. Surface water, in seasonally large quantities but of generally poor quality, is available from the Aley River, about 4 nautical miles to the southeast.

* For explanation of water terms, see Engineering Geology table footnote ***

Foundation conditions at the site are poor on both the sandy silt and the silty clay. The sandy silt is subject to liquefaction when saturated. Excavations are easy to dig, but walls require moderate to strong support, and seepage from lenses of silty sand may require control. Seismic velocities of materials to a depth of 200 feet beneath the site range between 1,000 and 3,000 feet per second.

Borrow sources of both sand and gravel and of bedrock suitable for crushing are well outside the area of the complex; silty sand is available from the terraces adjacent to the flood plain of the Aley River but probably is too fine-grained to exploit as a source of fine aggregate. Construction timber is not available near the launch site.

LAUNCH SITE 2

Launch Site 2 is located about 4.0 nautical miles west of Aleysk, and about 3.6 nautical miles northeast of Launch Site 1. Environmental conditions are similar to those at Launch Site 1.

LAUNCH SITE 3

Launch Site 3 is located about 4.7 nautical miles north-northwest of Aleysk, and about 3.6 nautical miles north-northeast of Launch Site 2. Except for a slightly deeper surficial layer of loess, environmental conditions are similar to those at Launch Site 1.

LAUNCH SITE 4

Launch Site 4 is located about 7.9 nautical miles northwest of Aleysk, about halfway between the Gorevko River and a road between Aleysk and Mokhovskoye. At this launch site, the surficial layer of loess is only about 10 feet thick, but the underlying strata are similar to those of the other launch sites. Surface water is available only seasonally, and in meager quantities, from the intermittent flow of the Gorevko River; furthermore, the quality is poor because of the high content of dissolved minerals. Other environmental conditions are similar to those at Launch Site 1.

LAUNCH SITE 5

Launch Site 5 is located about 11.7 nautical miles northwest of Aleysk, near the headquarters of the Aleysk State Farm (Sovkhoz Aleyskiy). Environmental conditions are similar to those at Launch Site 1.

LAUNCH SITE 6

Launch Site 6 is located about 9.8 nautical miles northwest of Aleysk, north of a road between Aleysk and Mokhovskoye near the Poperechikha River, and about 3.5 nautical miles north of Launch Site 4. The site is situated between two small drainageways tributary to the Poperechikha River. The surficial layer of loess which characterizes the other five sites is lacking, and the site rests directly upon the stratum of alternate layers of sandy silt and silty clay. Other environmental conditions are similar to those of Launch Site 1.

Section III. SUMMARY

The Aleysk ICBM complex is located on well-drained terrain of low relief nearly 300 nautical miles outside the zone of discontinuous permafrost. Launch sites are located on nearly level surfaces underlain by as much as 35 feet of loess and more than 500 feet of silt and clay. The water table is very deep except for perched water tables occurring in scattered lenses of silty sand, most of which are at depths in excess of 150 feet. Excavations are easy to dig, but walls would require support, particularly where lenses of silty sand are encountered. Foundation conditions within 200 feet of the surface are fair to very poor. Borrow sources for crushed stone and tiprap do not occur in the mapped area, nor do sources of sand and gravel for aggregate.

A study of the terrain of the Aleysk area does not suggest the presence of any topographic or soil factor as a major consideration in the precise location of the launch sites. However, all launch sites are naturally well drained and relatively close to a source of water, the Aley River, and to transportation facilities of the Turkestan-Siberian railroad.

Section IV. CODEWORD SOURCES

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DIAGRAMMATIC GEOLOGIC CROSS SECTIONS AT ALEYSK ICBM LAUNCH SITES

FOR LOCATIONS OF AREAS DIAGRAMMED, SEE MAP ON
PAGE 4; FOR EXPLANATION OF GEOLOGIC UNITS, SEE
TABLE ON PAGE 5.

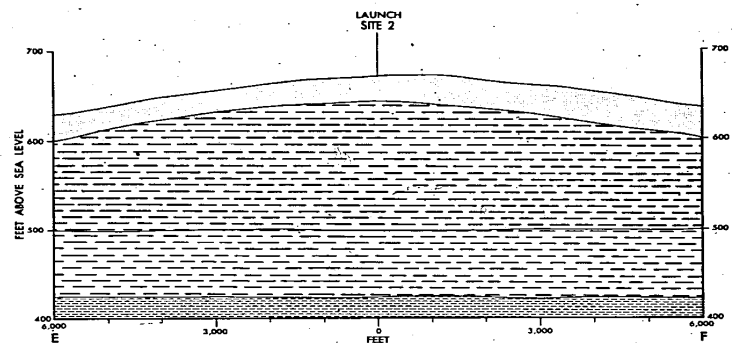
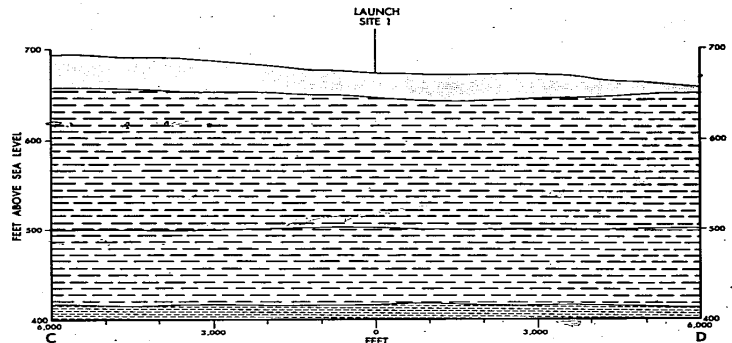
EXCEPT FOR PERCHED WATER TABLES OCCURRING IN
SILTY SAND LENSES, A GROUND-WATER TABLE IS LACKING.

HORIZONTAL SCALE 1:20,000
VERTICAL EXAGGERATION 20X

LAUNCH SITE CONFIGURATION

TYPE III (SINGLE)

Launch sites at the Aleysk ICBM complex
are currently in various stages of con-
struction and their final configurations
are undetermined. Therefore, no typical
diagram is shown and they are referred to
as Type III (single) sites.



RELIABILITY OF CROSS SECTIONS

THE CROSS SECTIONS ARE DRAWN ON THE BASIS OF DATA AVAILABLE FOR THE
GEOLOGY AND PHYSIOGRAPHIC FEATURES OF THE GENERAL AREA OF THE SITES,
MODIFIED BY TALENT-KEYHOLE PHOTOGRAPHY. ELEVATIONS ARE BASED ON ARMY MAP
SERVICE 1:250,000 SERIES N502, SHEET NN 44-12, WHICH WAS COMPILED FROM RUSSIAN
MAPS OF FAIR RELIABILITY DATED 1934-38. DRILLING DATA FOR THE AREA IS LACKING,
AND RELIABILITY OF LAYER THICKNESS IS PROBABLY $\pm 50\%$; RELIABILITY OF COMPOSITION
AND SEQUENCE OF LAYERS IS FAIR.

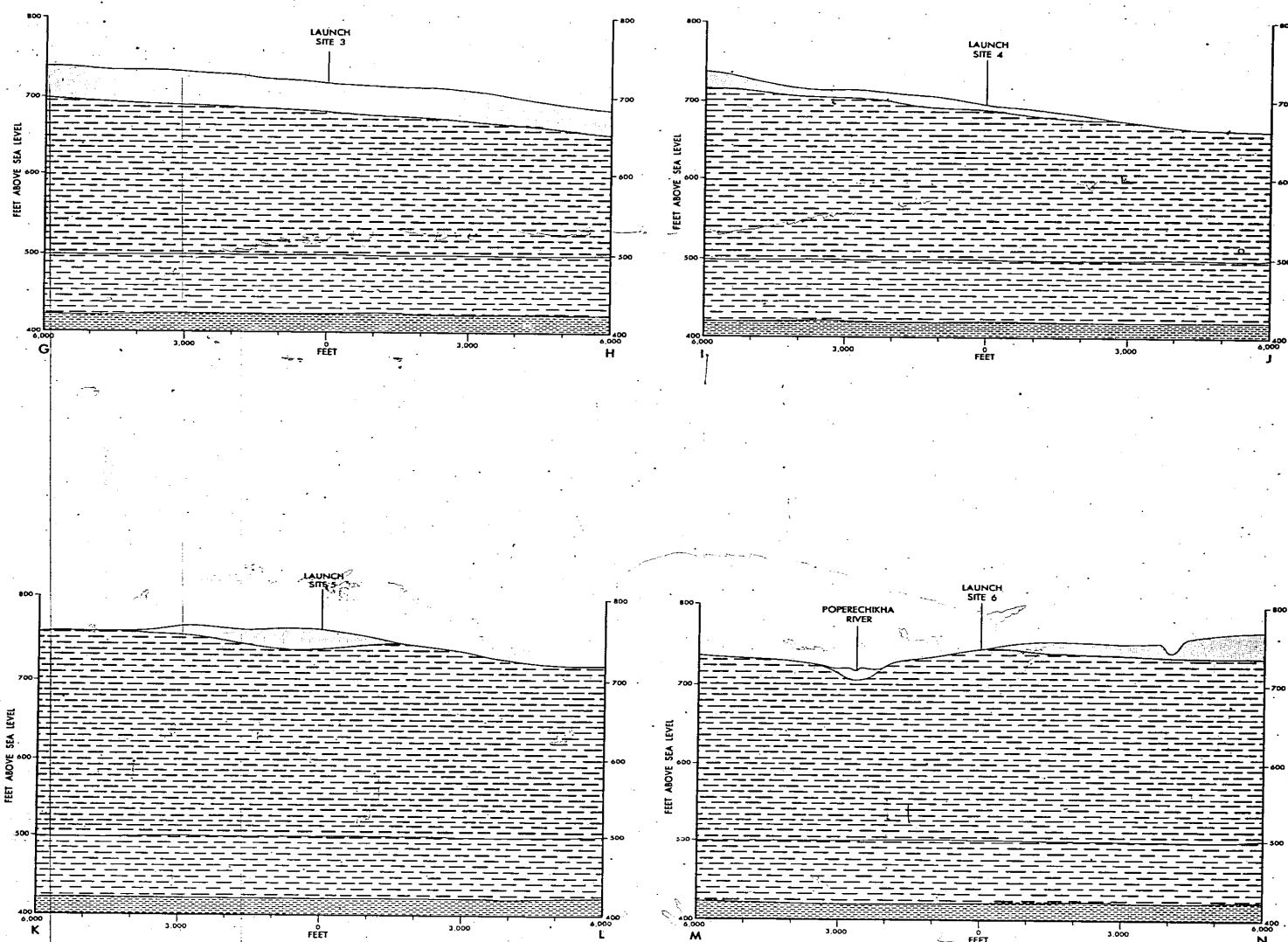
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DIAGRAMMATIC GEOLOGIC CROSS SECTIONS (CONTINUED)



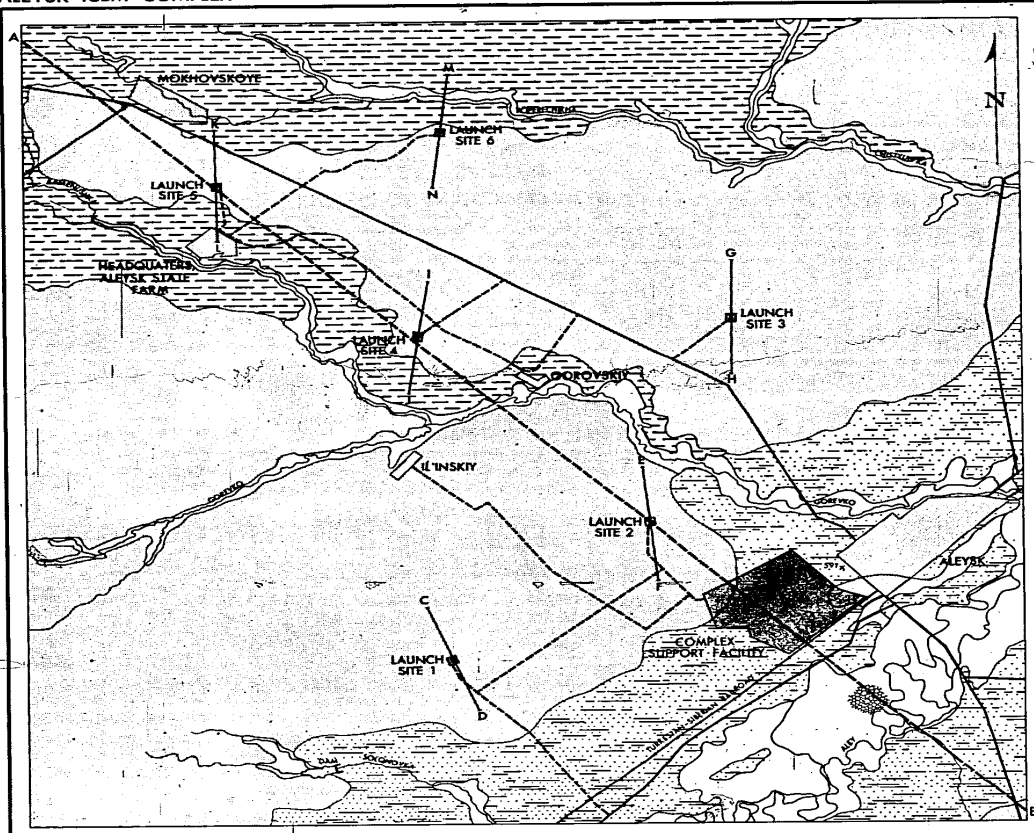
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ALEYSK ICBM COMPLEX

ENGINEERING GEOLOGY



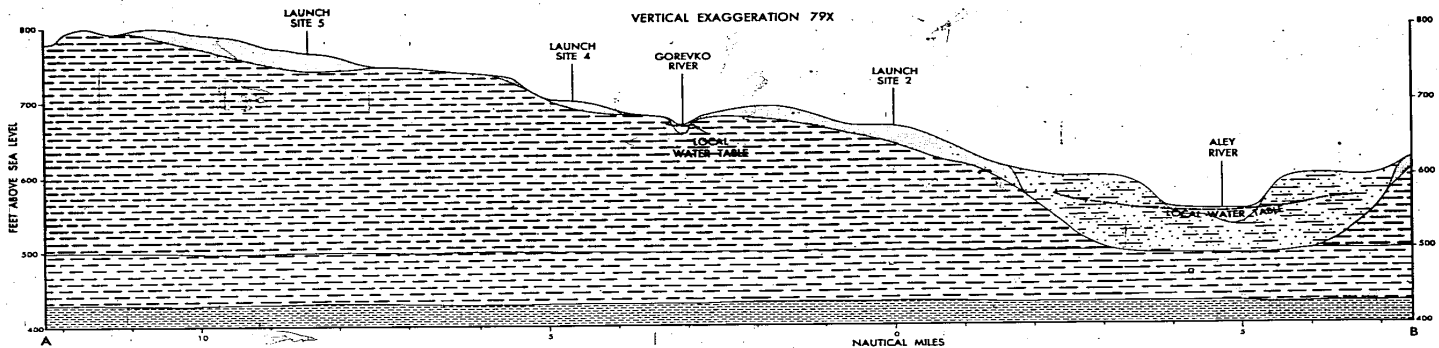
UNITS 6 AND 7 ARE NOT EXPOSED AT SURFACE (SEE CROSS SECTION).
ELEVATION IN FEET.
ELEVATION DATA FROM ARMY MAP SERVICE
1:250,000 SERIES N502, SHEET NN 44-12.

SCALE 1:95,000 (APPROXIMATE)
NAUTICAL MILES

LEGEND
ROAD,
FAIR WEATHER, LOOSE SURFACE
TRACK OR TRAIL
RAILROAD, 50' GAGE

DIAGRAMMATIC GEOLOGIC CROSS SECTION

VERTICAL EXAGGERATION 79X



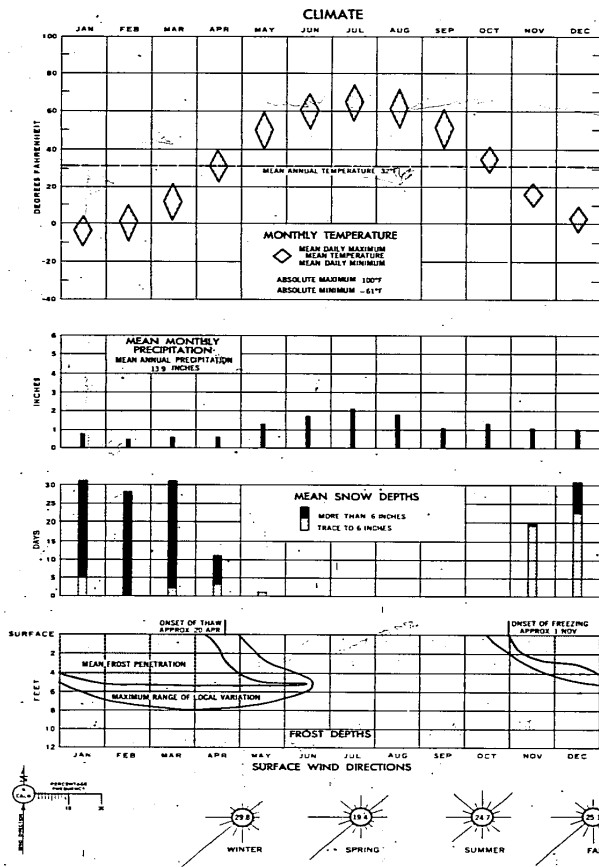
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